

(19) World Intellectual Property
Organization
International Bureau



(43) International Publication Date
16 June 2005 (16.06.2005)

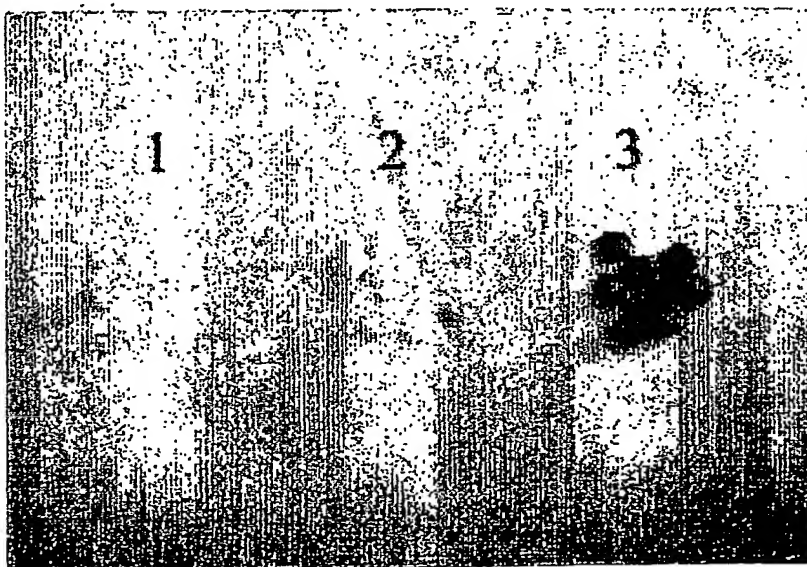
PCT

(10) International Publication Number
WO 2005/054120 A3

- (51) International Patent Classification⁷: **B22F 9/18**
- (21) International Application Number:
PCT/US2004/040826
- (22) International Filing Date: 6 December 2004 (06.12.2004)
- (25) Filing Language: English
- (26) Publication Language: English
- (30) Priority Data:
60/527,233 5 December 2003 (05.12.2003) US
- (71) Applicant (for all designated States except US): **IDAHO RESEARCH FOUNDATION, INC.** [US/US]; 103 Morrill Hall, University of Idaho, Moscow, ID 83844-3003 (US).
- (72) Inventors; and
- (75) Inventors/Applicants (for US only): **WAI, Chien, M.** [US/US]; 472 Ridge Road, Moscow, ID 83843 (US). **OHDE, Hiroyuki** [JP/JP]; 3 cho-me 12-10, Izuo, Taisho-ku, Osaka 551-0031 (JP). **OHDE, Mariko** [JP/JP]; 3 cho-me 12-10, Izuo, Taisho-ku, Osaka 551-0031 (JP).
- (74) Agent: **SLATER, Stacey, C.**; Klarquist Sparkman, LLP, One World Trade Center, Suite 1600, 121 SW Salmon Street, Portland, OR 97204 (US).
- (81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NA, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.
- (84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IS, IT, LT, LU, MC, NL, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).
- Published:
— with international search report
— before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments

[Continued on next page]

(54) Title: POLYMER-SUPPORTED METAL NANOPARTICLES AND METHOD FOR THEIR MANUFACTURE AND USE



(57) Abstract: A method for making polymer-supported metal nanoparticles (3) is disclosed comprising providing a polymer support material (1), contacting the support with a metal nanoparticle or metal nanoparticle precursor (2), and contacting the support material and metal or metal precursor with a fluid that swells the support material sufficiently to allow the metal or precursor to diffuse into the support material. The method also may comprise reducing the metal of the metal precursor to provide a metal nanoparticle. Typically, the support material is a plastic. The metal can be various metals including palladium, rhodium, platinum, iridium, osmium, gold, nickel, iron or combinations thereof. The nanoparticles can comprise alloys or aggregates of two or more metals. The fluid can be

any fluid that facilitates polymer swelling, one example being supercritical carbon dioxide. A method for performing chemical reactions comprises providing a polymer-supported metal nanoparticle and selected reagents under conditions allowing chemical reactions to occur. The method may involve reducing or oxidizing sites of unsaturation or functional groups. Relative amounts of the reduction products can be varied by selecting an appropriate metal nanoparticle, polymer support material, or both.

BEST AVAILABLE COPY

WO 2005/054120 A3



(88) Date of publication of the international search report:
4 August 2005

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US04/40826

A. CLASSIFICATION OF SUBJECT MATTER

IPC(7) : B22F 9/18
US CL : 75/351, 362, 369

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 75/351, 362, 369

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
WEST--search terms = nanoparticle (and variations), polymer near support or substrate, unsaturated near organic

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X --- A	US 2003/0139594 A1 (CAPAN et al.) 24 July 2003 (24.07.2003), see entire document.	1-7, 10-13, 21-32, 36-42, 45, 47, 48, 61, 66-68, 77, 78, 82-84 8, 9, 14-20, 33-35, 43, 44, 46, 49-60, 62-65, 69-76, 79-81

☐ Further documents are listed in the continuation of Box C.

☐ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

01 June 2005 (01.06.2005)

Date of mailing of the international search report

08 JUN 2005

Name and mailing address of the ISA/US

Mail Stop PCT, Attn: ISA/US
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450

Facsimile No. (703) 305-3230

Authorized officer

Roy V King

Telephone No. 571-272-1700